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Climate of the Past Discussions

Interactive comment on "Simulated stability of the AMOC during the Last Glacial Maximum under realistic boundary conditions" *by* Frerk Pöppelmeier et al.

Anonymous Referee #2

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In this paper, Pöppelmeier et al. present model simulations of the Atlantic Meridional Overturning Circulation (AMOC) at the Last Glacial Maximum (LGM) under different boundary conditions and model configurations. They use the Earth System Model of Intermediate Complexity BERN3D to explore the sensitivity of the LGM AMOC state to changes in wind stress, freshwater fluxes, Bering Strait and diapycnal diffusivity. Consistently with previous model results they find a stronger AMOC under realistic LGM boundary conditions. The paper is well written and the results are mostly clearly presented. The paper is of general interest for readers of Climate of the Past and fits the scope of the journal. I therefore recommend publication of the paper after the comments below (mostly minor) have been addressed.

1) Model configuration and setup would benefit from a more detailed description. I would for instance suggest to move the Appendix A1 to the main text, otherwise in the methods section there is no information on how the model is initialized etc. How is the carbon cycle initialized? What carbon cycle setup is used? Is it only ocean carbon cycle interacting with a one-box atmosphere? Are ocean sediments included? What about land carbon cycle and weathering? Is there any kind of interactive vegetation? Does CO2 affect any land properties?

2) Does topography have an effect in the model (besides of the effect on wind stress)? Would it be sensitive to different LGM ice sheet reconstructions?

3) Some general information on the simulated LGM climate would be useful to get an idea of how the model performs. What are e.g. changes in global temperature, ocean temperature, sea ice area in both Hemispheres?

4) The paper section describing the response in atmospheric CO2 concentration is poorly described and is missing a discussion of the ample available literature on the relation between AMOC and CO2 and more generally on the LGM carbon cycle, largely based on EMICs, with some of the studies even using the same model (BERN3D) (e.g. (Ganopolski and Brovkin, 2017; Kemppinen et al., 2019; Menviel et al., 2017)). Additionally, as already mentioned above, very little information on the carbon cycle setup is given in the paper.

5) There is no comparison of the different AMOC states with available reconstructions of isotopes in the ocean that would allow to make some statement of the likelihood of the different states. This is a pity considering that BERN3D includes several isotopes that could be used to constrain plausible LGM AMOC configurations, although the authors mention that this is in their future plans. Maybe the whole section dealing with simulated atmospheric CO2 concentration would fit better in one of those future papers...?

Line 8: were there really more icebergs during the deglaciation than at LGM?

Lines 26-27: I don't understand the logic behind this sentence. How is the fact that the AMOC is important for the Earth system related to it being (possibly) a tipping point?

Line 87: is the 0.5 Sv Bering Strait throughflow prescribed or computed by the model?

Line 305: where does this variability originate from in the model. Is it just noise? I guess there should be no interannual variability in a model like BERN3D...

Fig. 5b: red and black lines are very hard to distinguish, at least for color blind people.

References:

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